PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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Applicant:	Scott Dewey
Group Art Unit:	2838
Examiner:	Richard V. Muralidar
Title:	GIANT MAGNETORESISTIVE CELL MONITORING
Attorney Docket:	GP-303515

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APPELLANT'S THIRD APPEAL BRIEF

This is Appellant's Third Appeal Brief filed in response to the Examiner's Office Action mailed August 9, 2007 that reopened prosecution. Appellant's Second Appeal Brief was filed on March 10, 2007 in response to the Notice of Non-Compliant Appeal Brief mailed February 20, 2007. Appellant's original Appeal Brief was filed on December 18, 2006 in accordance with 37 CFR § 41.37 appealing the Examiner's Final Office Action mailed November 8, 2006. Appellant's Second Notice of Appeal is being filed concurrently herewith. The difference between the first Notice of Appeal fee and the current Notice of Appeal fee and the first Appeal Brief fee and the current Appeal Brief fee is enclosed.

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I. Real Party in Interest

The real party in interest for this appeal is the General Motors Corporation of Detroit, Michigan, the assignee of the application.

II. Related Appeals and Interferences

There are no related appeals or interferences.

III. Status of the Claims

Claims 1-20 are pending. Claims 1-20 are rejected. Claims 1-20 are on appeal. No claims have been cancelled. No claims have been allowed. No claims have been objected to.

IV. Status of Amendments

No amendments have been made.

V. Summary of Claimed Subject Matter

Independent apparatus claims 1 and 10 are directed to a monitoring system for monitoring the voltage across fuel cells 22 in a fuel cell stack 24, such as the cell monitoring system 20 shown in figure 3. Independent method claim 14 is a method for monitoring the voltage potential of the fuel cells 22 in the fuel cell stack 24, and closely parallels independent apparatus claim 1.

The monitoring system 20 includes a GMR device 28 having a wheatstone bridge 26, where at least one of the four resistors 30 in the bridge 26 is a giant magnetoresistive (GMR) resistor. The monitoring system 20 also includes a conductor 50 positioned in close proximity to the wheatstone bridge 26, and a plurality of switches

38-48 electrically coupled to the fuel cells 22 and to the conductor 50. The switches 38-48 are selectively switched on and off to separately electrically couple each fuel cell 22 in the fuel cell stack 24 to the conductor 50, and generate a current flow therethrough. As discussed in paragraph 0022, the current flow through the conductor 50 will produce a magnetic field that will upset the balance of the wheatstone bridge 26 by reducing the resistance of the GMR resistor. A differencing amplifier 52 amplifies the difference between the voltages at output ports 32 and 34 as a result of the imbalance, and provides an output signal that is a measurement of the voltage output of the particular fuel cell 22 currently coupled to the conductor 50. Because the coupling between the conductor 50 and the wheatstone bridge 26 is magnetic coupling, the GMR device 28 is electrically isolated from the high voltage of the fuel cell stack 24.

In one embodiment, the monitoring system 20 includes a polarity reverser that reverses the polarity of the current for every other fuel cell before the current is sent to the conductor 50 so that the current through the conductor 50 is always propagating in the same direction. This is desirable because the fuel cells 22 in the fuel cell stack 24 are electrically coupled together in series where a common electrical plate is provided between adjacent fuel cells. By sequentially measuring the voltage of the fuel cells in the fuel cell stack, a particular electrical plate will be a positive plate in one voltage measurement, and then will be a negative plate in the next voltage measurement. A discussion of the polarity reverser can be found in paragraph 0026 of the specification.

VI. Grounds of Rejection to be Reviewed on Appeal

Whether claims 1-4, 6-10, 12-17, 19 and 20 should be rejected under 35 USC §103(a) as being unpatentable over U.S. Patent No. 6,762,587 issued to Barbetta

(hereinafter Barbetta) in view of U.S. Patent No. 4,937,521 issued to Yoshino et al. (hereinafter Yoshino); and

Whether claims 5, 11 and 18 should be rejected under 35 USC §103(a) as being unpatentable over Barbetta in view of Yoshino, U.S. Patent No. 5,371,455 issued to Chen (hereinafter Chen) and U.S. Patent No. 3,500,372 issued to Thiele (hereinafter Thiele).

VII. Argument

A. Claims 1-4, 6-10, 12-17, 19 and 20 are not obvious in view of Barbetta and Yoshino

1. Independent claims 1, 10 and 14

Independent claims 1, 10 and 14 claim a monitoring system or method for monitoring the voltage potential of fuel cells in a fuel cell stack. The system employs a wheatstone bridge having a giant magnetoresistive resistor, and a conductor positioned proximate to the wheatstone bridge. A plurality of switches selectively electrically couple the fuel cells to the conductor. The current flowing through the conductor as a result of the voltage potential across the fuel cell generates a magnetic field that operates to reduce the resistance of the GMR resistor and unbalance the wheatstone bridge so that the voltage potential can be measured.

2. *Prima facie* obviousness

MPEP 2143 states that in order to establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art

reference(s) must teach or suggest all of the claim limitations. Applicant submits that the Examiner has not established a *prima facie* case of obviousness because there is no teaching, suggestion or motivation in either Barbetta or Yoshino, or in the knowledge generally available to one of ordinary skill in the art, to use a wheatstone bridge including a magnetorestive resistor for a fuel cell voltage monitoring device.

MPEP 2143.01 I addresses the requirements for the first criteria of *prima facie* obviousness, particularly the suggestion or motivation to modify references. That section states that there are three (3) possible sources for a motivation to combine references, namely, the nature of the problem to be solved, the teachings of the prior art and the knowledge of persons of ordinary skill in the art, citing In Re Rouffet, 149 F.3d, 1350, 1357, 47 USPQ2d 1453, 1457-58 (Fed. Cir. 1998). The In Re Rouffet Court stated that the combination of the references taught every element of the claimed invention, however, without a motivation to combine, a rejection based on a *prima facie* case of obviousness is improper. Further, MPEP 2143.01 states that the Court in Al-Site Corp. v. VSI Int'l Inc., 174 F.3d 1308, 50 USPQ 2nd 1161 (Fed. Cir. 1999) stated that the level of skill in the art cannot be relied upon to provide the suggestion to combine references.

MPEP 2143.01 I also states that, "[o]bviousness can only be established by combining or modifying the teachings of the prior art to produce the claimed invention where there is some teaching, suggestion, or motivation to do so, either explicitly or implicitly in the reference themselves, or in the knowledge generally available to one of ordinary skill in the art. The test for an implicit showing is what the combined teachings, knowledge of one of ordinary skill in the art, and the nature of the problem to be solved

as a whole, would have suggested to those of ordinary skill in the art." In Re Kotzab, 217 F.3d 1365, 1370, 55 USPQ 2d 1313, 1317 (Fed. Cir. 2000).

The nature of the problem addressed by Applicant's invention is to provide a reliable and inexpensive technique for monitoring the voltages of the fuel cells in a fuel cell stack. Appellant submits that nothing in Barbetta or Yoshino would suggest to a person of ordinary skill in the art that using a device employing a giant magnetoresistive resistor to measure current flow through a conductor can be used for monitoring the voltage of the fuel cells in a fuel cell stack.

MPEP 2143.01 III states that the mere fact that references can be combined or modified does not render the combination obvious unless the prior art also suggests the desirability of the combination. Therefore, the fact that the current detecting device taught by Yoshino could be combined with the Barbetta fuel cell voltage monitoring device is not relevant because Yoshino does not teach or suggest that its current detecting device can be used in such a manner.

MPEP 2143.01 IV states that statements that the modification of the prior art based on the references would have been well within the ordinary skill of the art at the time the invention was made because the references relied upon teaches that all aspects of the claimed invention were individually known in the art is not sufficient to establish a *prima facie* case of obviousness without some objective reason to combine the teachings of the references. MPEP 2143.01 cites In Re Kotzab, 217 F3d 1365, 1371, 55 USPQ 2d, 1313, 1318 (Fed. Cir. 2000) to support this position, where the Court held that *prima facie* obviousness was not established because there was no finding as to the principle or specific understanding within the knowledge of a skilled artisan that would have motivated the skilled artisan to make the claimed invention.

3. Barbetta

Appellant states in paragraph [0007] of the background discussion that it is necessary to monitor the output voltage of each fuel cell during operation of the fuel cell stack to ensure that each fuel cell is operating properly. Barbetta discloses one representative system for measuring the voltage of fuel cells in a fuel cell stack as Appellant has suggested is known. Particularly, the Barbetta voltage monitoring system employs a particular contact and switch assembly that is selectively actuated to make electrical connections to individual cells or groups of cells in the fuel cell stack to measure the voltage of the individual cells or groups of cells. Appellant submits that nowhere in Barbetta does it teach or suggest using a wheatstone bridge including at least one giant magnetoresistive resistor that provides a voltage measurement in response to a current flowing through a conductor.

4. Yoshino

Appellant states in paragraph [0008] of the background discussion that the giant magnetoresistive phenomenon that uses a magneto resistor whose resistance changes in response to a magnetic field is known in the art. Yoshino discloses a representative example of a current detecting device based on this phenomenon. Figure 11 in Yoshino shows a current detecting circuit including a bridge circuit having a magneto resistor 1, where the bridge circuit measures the current flow through a conductor 3. However, Appellant submits that nowhere in Yoshino does it teach or suggest using the current detecting circuit to measure the voltage <u>of fuel cells in a fuel cell stack</u>.

5. Discussion

The Examiner's discussion as to how claims 1-4, 6-10, 12-17, 19 and 20 are obvious under Barbetta in view of Yoshino included in the Office Action mailed August 9, 2007 is the same as the discussion of these claims in the Final Office Action mailed November 8, 2006, except that the August 9th Office Action did not include the Response to Arguments section beginning on page 10 of the Final Office Action mailed November 8th. The discussion below concerning Barbetta and Yoshino refers back to the final Office Action mailed November 8, 2006.

Appellant submits that the Examiner has not established a *prima facie* case of obviousness because there is no teaching, suggestion or motivation in either Barbetta or Yoshino, or in the knowledge generally available to one of ordinary skill in the art, to use a wheatstone bridge having a magnetoresistive resistor for measuring the current flow through a conductor electrically coupled to a fuel cell so as to measure the voltage of the fuel cell. The nature of the problem addressed by Appellant's invention is to provide a reliable and inexpensive technique to monitor the voltages of the fuel cells in the fuel cell stack. Appellant submits that nothing in Barbetta or Yoshino would suggest to a person of ordinary skill in the art that using a current sensing device employing a giant magnetoresistive resistor to measure the current flow through the conductor can be used for monitoring the voltage of the fuel cells in a fuel cell stack. Because it is improper to combine reference teachings even though they can be combined unless the prior art also suggests the desirability of the combination, the fact that the current detecting device taught by Yoshino could possibly be combined in the Barbetta fuel cell voltage monitoring device is not relevant because Yoshino does not teach or suggest that its current detecting device can be used in such a manner.

In response to the first Office Action, Appellant submitted that the Examiner had failed to provide a reason as to why one of ordinary skill in the art would combine the current detecting device of Yoshino into the fuel cell voltage detecting device of Barbetta, and therefore used improper hindsight in this combination. Particularly, Appellant stated that In Re Conn, 78 USPQ2d 1329 (CAFC 2006) addresses the motivation/suggestion/teaching element of establishing a *prima facia* case of obviousness. The Court in In Re Conn at 1335 stated that the PTO is required to explain the motivation, suggestion or teaching that would have led the skilled artisan at the time of the invention to claim the combination as a whole, otherwise the PTO has used hindsight to conclude that the invention was obvious. The Examiner states on page 3 of the Office Action that "Barbetta and Yoshino et al. are analogous current measuring devices," and "[a]t the time of the invention it would have been obvious to add a Wheatstone bridge with GMR type resistors to Barbetta for the benefit of accurately reading current/voltage of each cell while ensuring isolation existed between the cells high voltage and the measurement electronics . . . ". However, what Appellant submits that the Examiner has failed to do is explain why one of ordinary skill in the art would combine the current detecting device of Yoshino et al. into the fuel cell voltage detecting device of Barbetta, and therefore has used improper hindsight.

In response thereto, the Examiner stated in the final Office Action that he relies on the portion of MPEP 2143.01 that states, "...or in the knowledge generally available to one of ordinary skill in the art" to satisfy the motivation to combine Yoshino and Barbetta. Thus, it is the Examiner's position that neither Yoshino nor Barbetta independently or together provide the motivation to combine their teachings. Therefore, it is clear that the Examiner himself is providing the "knowledge generally available to one of ordinary skill in the art."

The Examiner then goes on to use his general knowledge of ordinary skill in the art to provide a reasoning as to why the skilled artisan would combine Barbetta and Yoshino in points (1)-(8) on pages 11 and 12 of the final Office Action. First, Appellant submits that if it requires an eight step process to arrive at obviousness, then it is unlikely on its face that the process is *prima facie* obvious.

The Examiner provides the following reasoning in points (1) - (8):

> It is desirable to measure the quality of power from the fuel cells in a fuel cell stack;
>
> The modern technique for monitoring voltage is using a microprocessor;
>
> Microprocessors are low voltage circuits that require isolation; and
>
> Thus the skilled artisan would look for the <u>best</u> technique to monitor the fuel cell voltage while insuring isolation between the microprocessor and the fuel cells.
>
> The Examiner, as the skilled artisan, would then rule out the most common forms of voltage measurement, such as current sensing resistors and transformers, because current sensing resistors offer no isolation and waste power through heat dissipation, and transformers are inaccurate and expensive. Upon elimination of these devices, the skilled artisan (Examiner) would arrive at the conclusion that using the giant magnetoresistive phenomenon in a wheatstone bridge as claimed by Applicant would be the best current detecting device to measure the voltage of the fuel cells and provide electrical isolation.

Appellant acknowledges the Examiner's artful discussion to come up with a motivation as to why combine Barbetta and Yoshino. However, it is still Appellant's opinion that this discussion does not satisfy a *prima facie* case of obviousness, and the Examiner has improperly used hindsight. For example, based on the Examiner's analysis, using a giant magnetoresistive resistor in a wheatstone bridge as claimed by

Applicant is the best way of measuring the voltage of fuel cells in a fuel cell stack. However, Appellant submits that if this were in fact true and that it is the best way and is obvious, then skilled artisans other than the Examiner would have previously used this technique for measuring the voltage of fuel cells in a fuel cell stack, because all fuel cell systems monitor these voltages. Particularly, it is Appellant's position that if using a giant magnetoresistive resistor in a wheatstone bridge for measuring the voltage of fuel cells in a fuel cell stack is the best way of measuring the voltage, and it is obvious to do so, then the prior art would specifically indicate that. Thus, Appellant submits that the combination of Barbetta and Yoshino is outside the scope of *prima facie* obviousness.

B. Dependent claims 5, 11 and 18 are not obvious in view of Barbetta, Yoshino, Chen and Thiele

Dependent claims 5, 11 and 18 include a polarity reverser that reverses the polarity of the current from every other fuel cell before the current is applied to the conductor so that the current through the conductor is always propagating in the same direction.

Appellant submits that Barbetta does not teach a polarity reverser in its fuel cell voltage monitoring device because Barbetta is not using the propagation of current through a conductor as part of the device. Further, Appellant submits that the current detecting device in Yoshino would not need a polarity reverser because there is no indication in Yoshino that the current detected by the device could be propagating through the conductor in opposite directions.

Chen discloses a control circuit for charging a rechargeable battery that has particular application for charging a vehicle battery. Column 1, line 50 - column 2, line 2 of Chen, identified by the Examiner, talks about a reverse-polarity detection circuit that can detect whether the terminals of the charging device have been properly connected

to the terminals of the battery. If the terminals are not connected properly an automatic change switch reverses the positive and negative terminals of the charging device so that it is properly connected to the battery. The Examiner states in the paragraph discussing Chen on page 10 of the Office Action mailed August 9th, "said polarity reverser reversing the polarity of the current from the cells before the current is applied to the conductor so that the current through the conductor is always in the same direction." Appellant is unsure as to what cells or what conductor the Examiner is referring to because Chen does not talk about cells or a conductor. Appellant submits that Chen does not teach or suggest a polarity reverser in a monitoring circuit for monitoring the voltage across fuel cells in the fuel cell stack where the polarity reverser reverses the voltage polarity from fuel cells so that the current sent to the conductor positioned in close proximity to a wheatstone bridge always flows in the same direction. Therefore, Appellant submits that Chen does not provide the teaching missing from Barbetta and Yoshino to make dependent claims 5, 11 and 18 obvious.

Thiele discloses an electrochemical battery monitoring system for monitoring the fuel cells in a fuel cell battery. The Examiner has directed Appellant's attention to column 1, lines 12-39 as teaching a polarity reverser of the type claimed by Appellant. This section of Thiele talks about the voltage of the cells in the battery sometimes dropping significantly and possibly going into a reverse polarity situation where the positive side of the fuel cell becomes negative and the negative side of the fuel cell becomes positive relative to the other cells. Such a situation can have catastrophic failures for a fuel cell stack if it is not prevented.

Appellant submits that identifying the well known technique of polarity reversal of a fuel cell in a fuel cell stack is very different than employing a polarity reverser in a fuel cell voltage monitoring system where the polarity reverser switches the polarity of every

other fuel cell so that the current applied to a conductor adjacent a wheatstone bridge always flows in the same direction.

VIII. Conclusion

Appellant respectfully submits that claims 1-4, 6-10, 12-17, 19 and 20 are not obvious in view of Barbetta and Yoshino, and claims 5, 11 and 18 are not obvious in view of Barbetta, Yoshino, Chen and Thiele. Therefore, it is respectfully requested that these rejections be withdrawn.

Respectfully submitted,

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CLAIMS APPENDIX

COPY OF CLAIMS INVOLVED IN THE APPEAL

1. A monitoring system for monitoring the voltage potential of fuel cells in a fuel cell stack, said system comprising:

a wheatstone bridge, said wheatstone bridge including at least one giant magnetoresistive (GMR) resistor and two output ports;

a conductor positioned proximate to the wheatstone bridge;

a plurality of switches electrically coupled to the fuel cells and to the conductor, said switches being selectively switched on and off to separately and selectively couple each fuel cell in the fuel cell stack to the conductor and generate a current flow therethrough, wherein a magnetic field generated by the current flow through the conductor reduces the resistance of the GMR resistor and unbalances the wheatstone bridge; and

a differencing amplifier electrically coupled to the output ports of the wheatstone bridge, said differencing amplifier providing an output signal indicative of the voltage potential of the selected fuel cell.

2. The system according to claim 1 wherein the switches are FET switches.

3. The system according to claim 1 wherein the at least one GMR resistor is two GMR resistors.

4. The system according to claim 1 wherein the conductor is an electrical trace positioned beneath the wheatstone bridge.

5. The system according to claim 1 further comprising a polarity reverser, said polarity reverser reversing the polarity of the current from the fuel cells before the current is applied to the conductor so that the current through the conductor is always in the same direction.

6. The system according to claim 1 further comprising at least one voltage divider electrically coupled between the fuel cells and the conductor.

7. The system according to claim 1 further comprising a controller for controlling the switches to separately measure the voltage potential of each fuel cell and for receiving the output signal from the amplifier.

8. The system according to claim 7 further comprising a plurality of opto-isolators for isolating the high voltage of the fuel cell stack and the switches from the low voltage of the controller.

9. The system according to claim 1 wherein the system monitors the fuel cell stack on a vehicle.

10. A monitoring system for monitoring the voltage potential of fuel cells in a fuel cell stack, said system comprising:

a wheatstone bridge, said wheatstone bridge including at least one giant magnetoresistive (GMR) resistor and two output ports;

an electrical trace positioned beneath the wheatstone bridge;

a plurality of FET switches electrically coupled to the fuel cells and to the trace, said FET switches being selectively switched on and off to separately and selectively couple each fuel cell in the fuel cell stack to the trace and generate a current flow therethrough, wherein a magnetic field generated by the current flow through the trace reduces the resistance of the GMR resistor and unbalances the wheatstone bridge;

a differencing amplifier electrically coupled to the output ports of the wheatstone bridge, said differencing amplifier providing an output signal indicative of the voltage potential of the selected fuel cell; and

a controller for controlling the switching of the FET switches to separately measure the voltage potential of each fuel cell and for receiving the output signal from the amplifier.

11. The system according to claim 10 further comprising a polarity reverser, said polarity reverser reversing the polarity of the current from the fuel cells before the current is applied to the trace so that the current through the trace is always in the same direction.

12. The system according to claim 10 further comprising at least one voltage divider electrically coupled between the fuel cells and the trace.

13. The system according to claim 10 further comprising a plurality of opto-isolators for isolating the high voltage of the fuel cell stack and the FET switches from the low voltage of the controller.

14. A method for monitoring the voltage potential of fuel cells in a fuel cell stack, said method comprising:

providing a wheatstone bridge including at least one giant magnetoresistive (GMR) resistor and two output ports;

providing a conductor positioned proximate to the wheatstone bridge;

selectively and separately electrically coupling the fuel cells to the conductor to generate a current flow through the conductor, wherein a magnetic field generated by the current flow through the conductor reduces the resistance of the GMR resistor and unbalances the wheatstone bridge; and

electrically coupling the output ports of the wheatstone bridge to a differencing amplifier, said differencing amplifier providing an output signal indicative of the voltage potential of the selected fuel cell.

15. The method according to claim 14 wherein selectively and separately electrically coupling the fuel cells to the conductor includes using FET switches to selectively and separately electrically couple the fuel cells to the conductor.

16. The method according to claim 14 wherein providing a conductor positioned proximate to the wheatstone bridge includes providing an electrical trace positioned beneath the wheatstone bridge.

17. The method according to claim 14 wherein providing a wheatstone bridge includes providing a wheatstone bridge including two GMR resistors.

18. The method according to claim 14 further comprising providing a polarity reverser for reversing the polarity of the current from the fuel cells before the current is applied to the conductor so that the current through the conductor is always in the same direction.

19. The method according to claim 14 further comprising providing at least one voltage divider electrically coupled between the fuel cells and the conductor.

20. The method according to claim 14 wherein the fuel cell stack is on a vehicle.

EVIDENCE APPENDIX

There is no evidence pursuant to §1.130, §1.131 or §1.132.

RELATED PROCEEDINGS APPENDIX

There are no decisions rendered by a court or the Board in any proceeding identified in Section II of this Appeal Brief.